Emittance growth of Pb-ions at 17 GeV.

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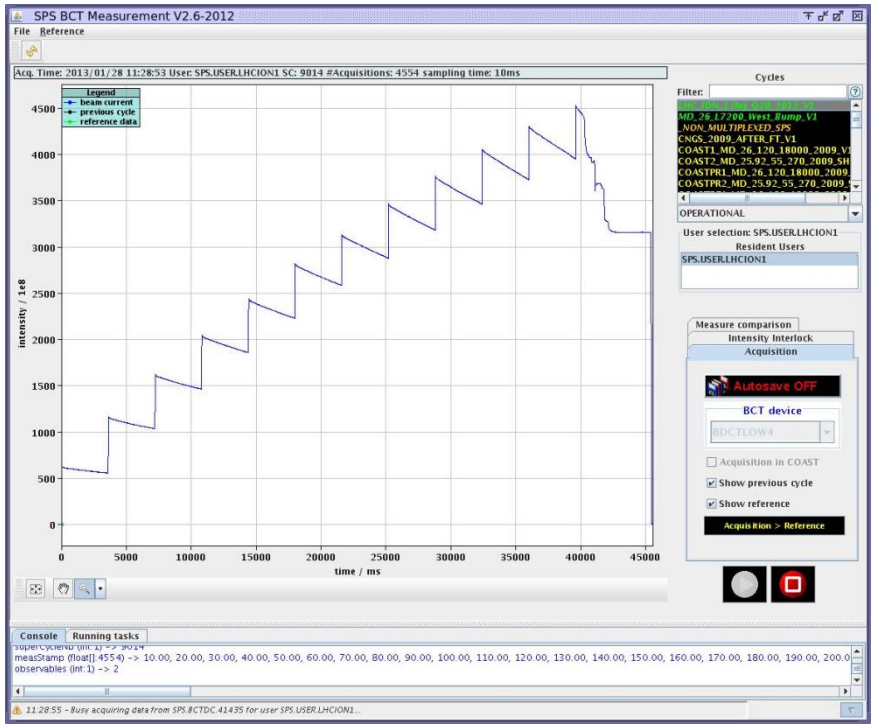
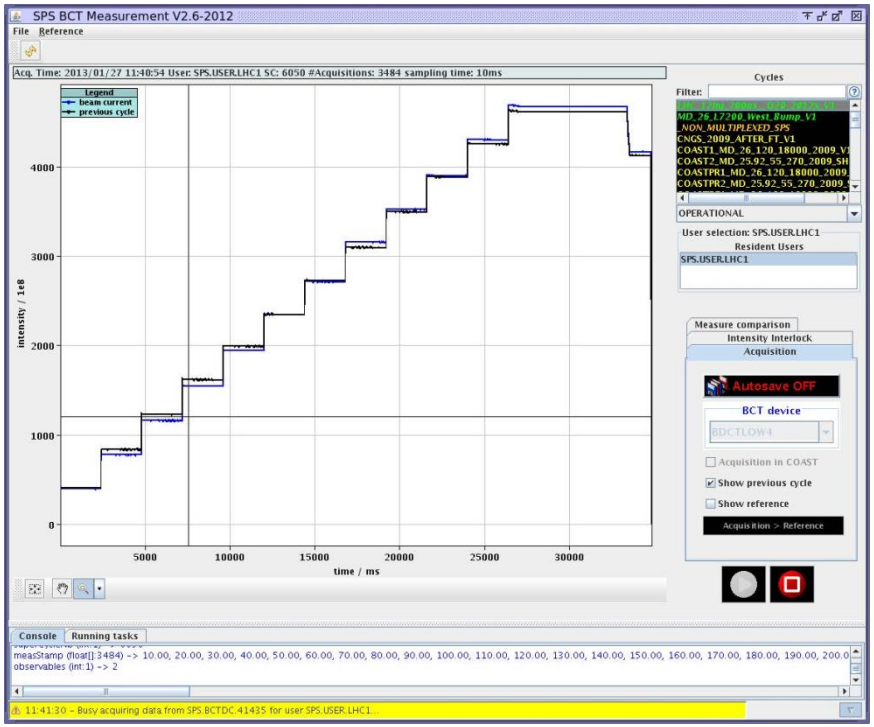
Why are Ions so different?

Lead ions

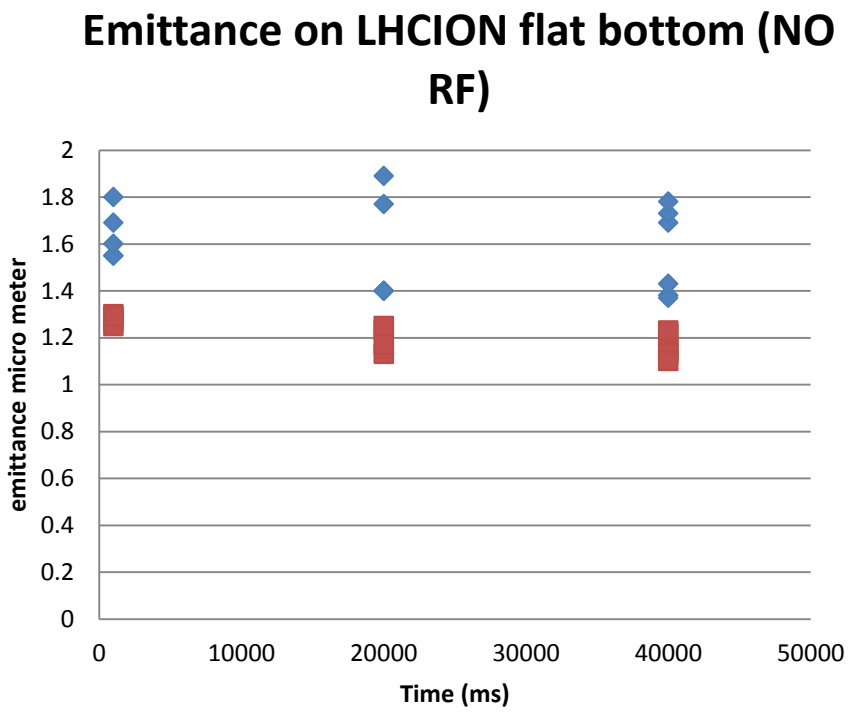


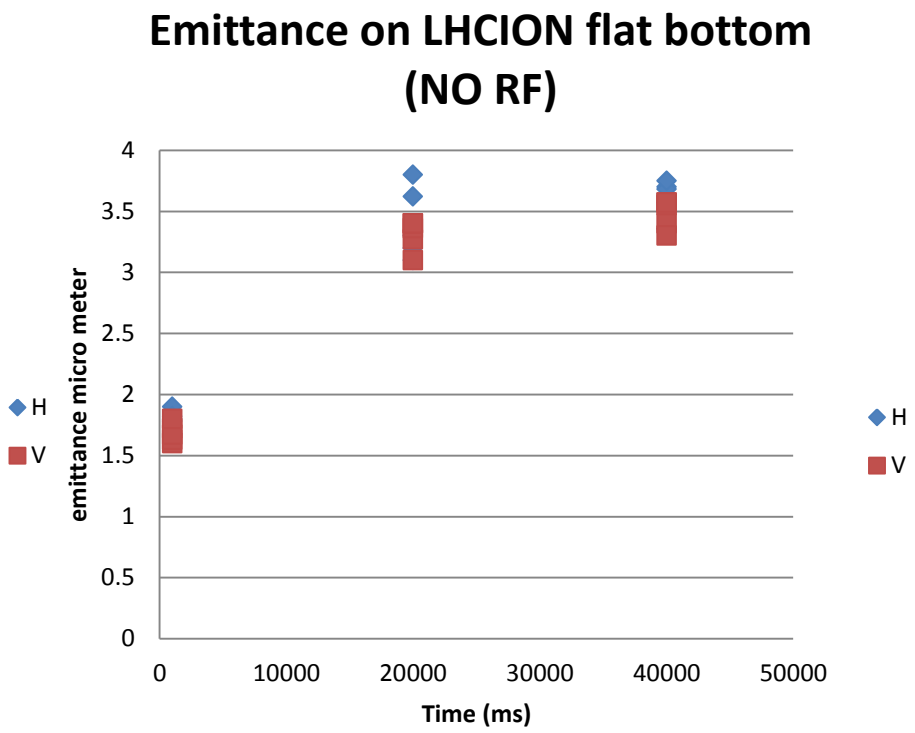
Protons



Emittance behaviour at 17 GeV

Intensity 3.5 E10 charges per bunch





Suspected parameters

Space charge $$\delta\nu_{x,y} = -\frac{N_b r_i}{(2\pi)^{3/2}\beta^2\gamma^3\sigma_z}\oint\frac{\beta_{x,y}}{\sigma_{x,y}(\sigma_x+\sigma_y)}ds$$

(0.13,0.2)

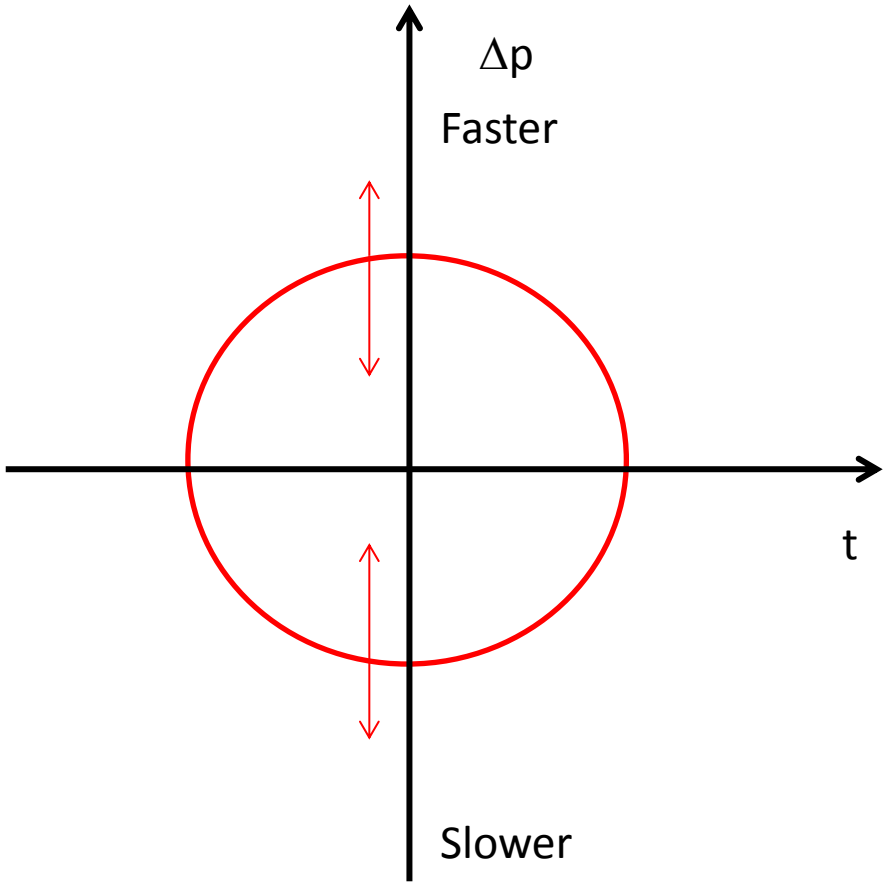
Intrabeam scattering $$A=\frac{r_i^2 c N_b}{64\pi^2\beta^3\gamma^4\varepsilon_x\varepsilon_y\sigma_z\sigma_p}$$ X horrible integrals depending a.o. on optics.

Space charge plays certainly a role (no freedom for vertical tune), but what is the impact of IBS ?

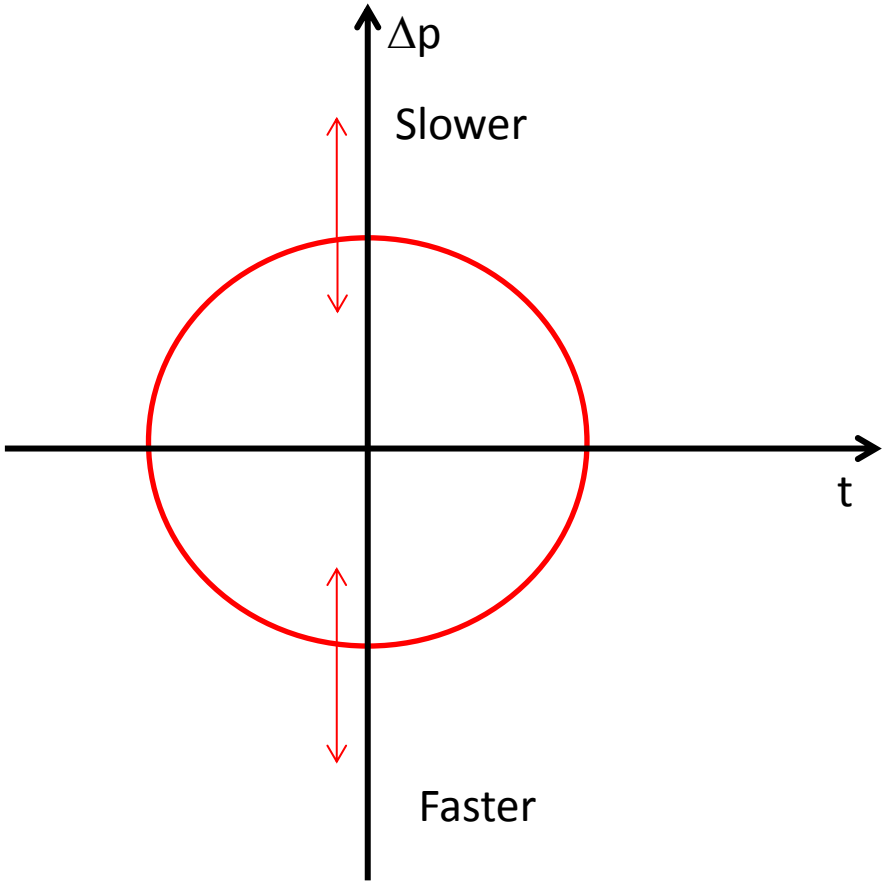
IBS : how it works ?

- A particle that moves forward through the bunch gets knocked by the particles on its way. On the average it gives away momentum, but it also sometimes gains momentum from particles going faster.
- The particles that moves backwards get mainly hit in the back (increased momentum) but sometimes are knocked back by even slower particles.

IBS : longitudinal phase space



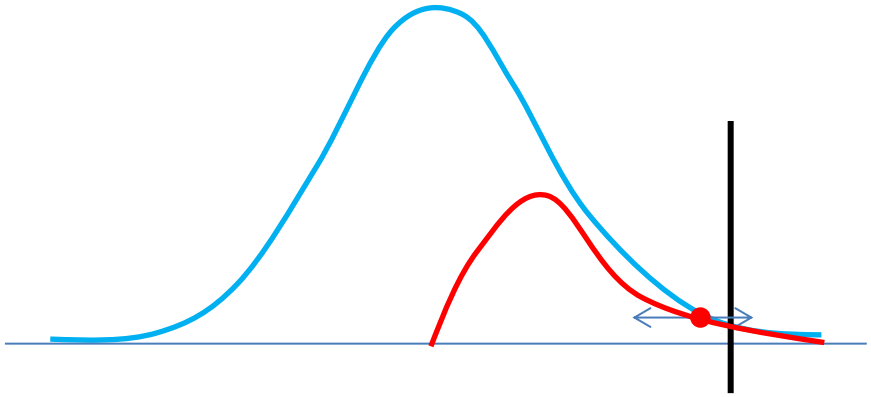
Below transition



above transition

IBS

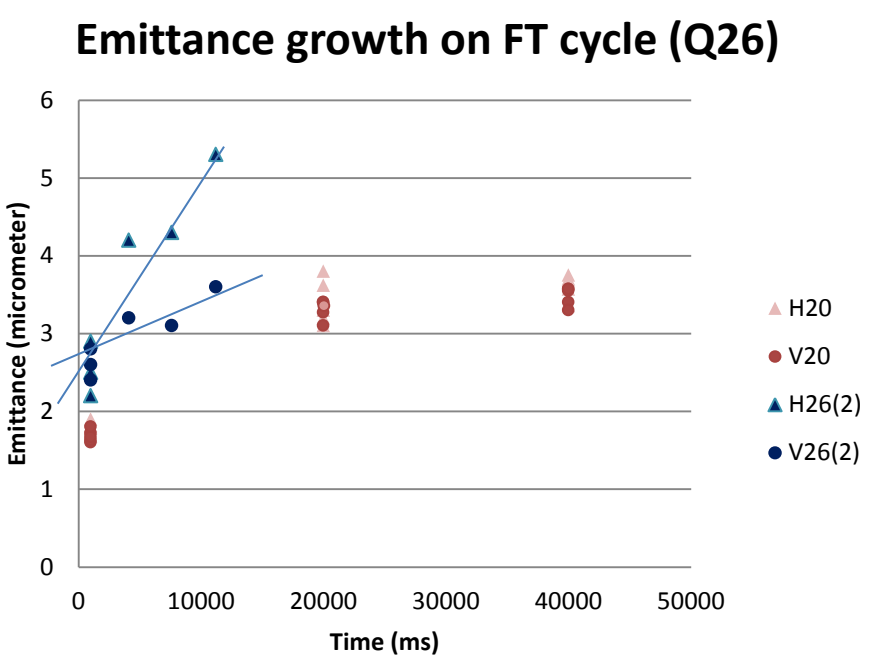
- Below transition the longitudinal motion behaves like a damped oscillator with noise.
- The result will be an Gaussian equilibrium shape.
- Important : any particle can move anywhere in the amplitude distribution. Losses will keep on occurring.
- The speed at which the equilibrium is attained and by which the particles scan different oscillation amplitudes depends on the bunch density.

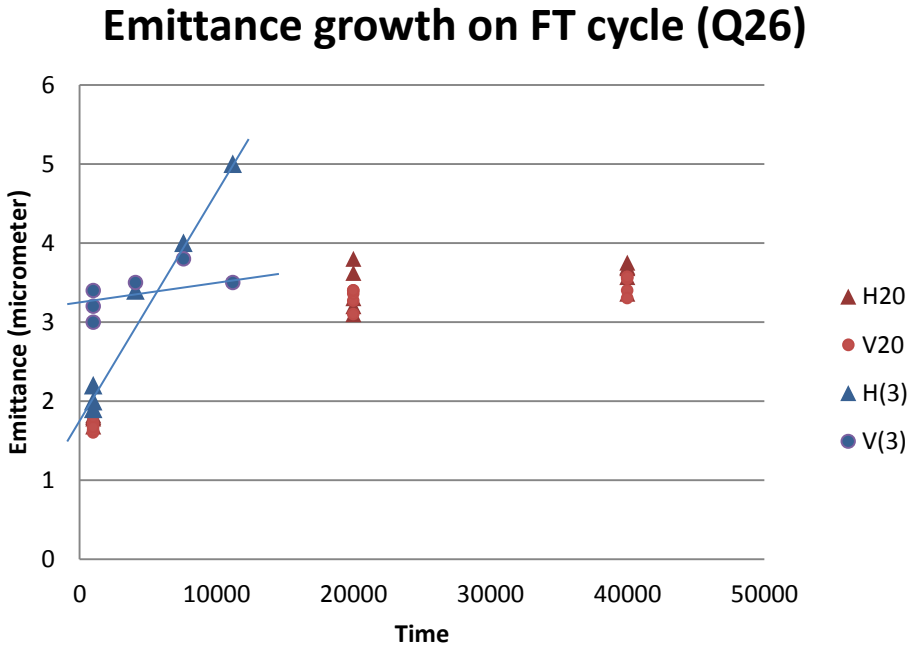


IBS in Horizontal plane.

- Random momentum kicks in dispersion regions result in random horizontal kicks giving horizontal blow up.
- There is no damping but the phenomena will slow down as the bunch density is lowering.

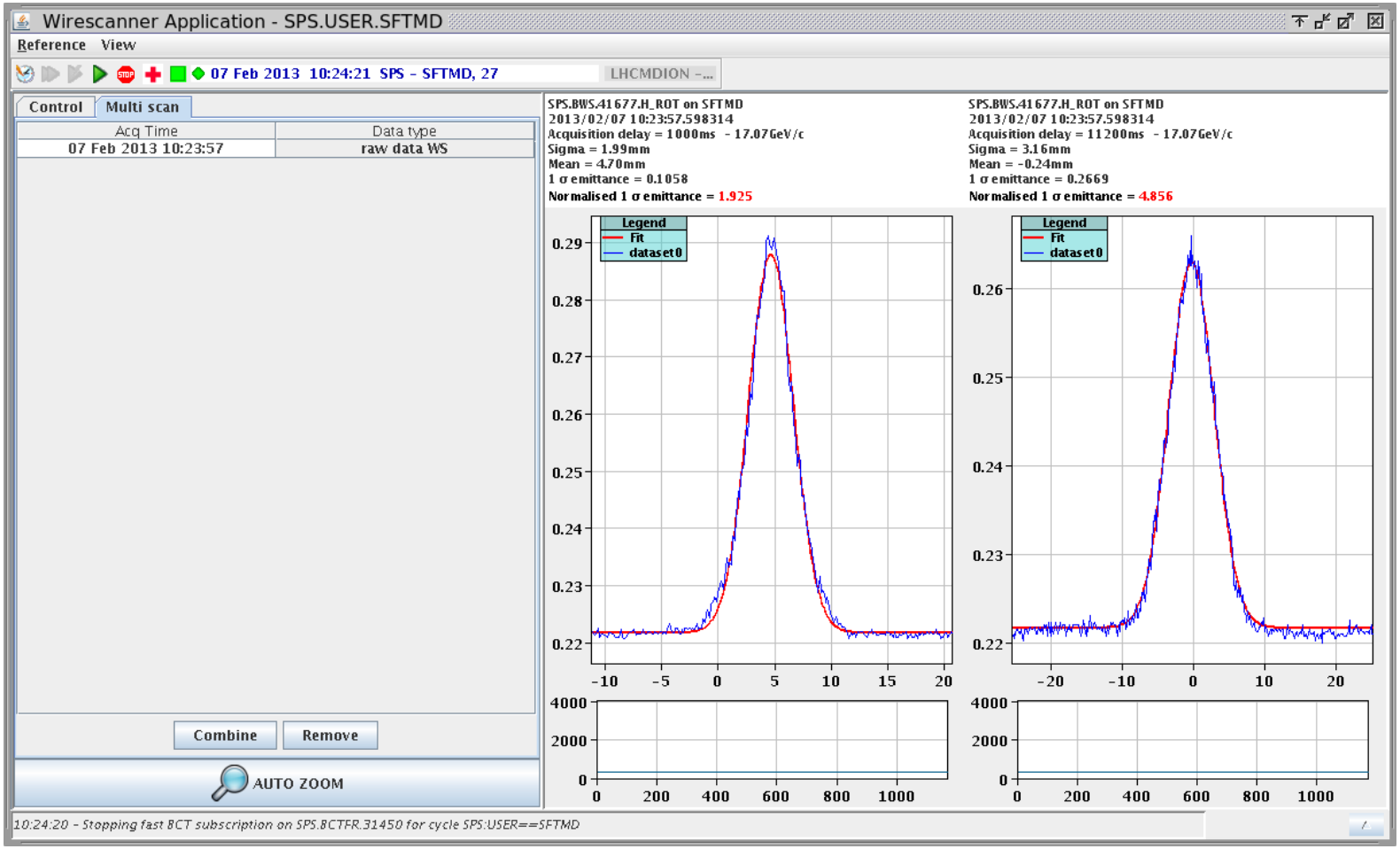
Comparison Q20 and Q26





-For Q26 optics, emittance growth mainly in horizontal plane

Horizontal beam profiles



SUMMARY

- Transverse emittances of Lead Ions are growing at 17GeV.
- Growth rates vary from 10^{-1} s^{-1} to 20^{-1} s^{-1}
- Horizontal blow more important on FT cycle
- Hints for IBS contribution.